PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

Friday, May 13, 1887.—Henry Pollock, Esq., Treasurer and Vice-President, in the Chair.

Some Electrical Fishes. By Professor J. S. Burdon Sanderson, M.D., LL.D., F.R.S.

The lecture was divided into three parts, in the first of which a general description was given of the three most important electrical fish, viz. the torpedo, or electrical ray, the electrical eel of the rivers and lakes of South America, and the *Malapterurus* of the Nile and Senegal. In the second part the lecturer discussed the anatomical character and morphological significance of the electrical organ in the torpedo, and in the third its mode of action, with special reference to the recent investigations of Mr. Francis Gotch, Assistant in the Physiological Department at Oxford. The description given of the structure of the organ was also founded on new investigations by Prof. Ewart, of Edinburgh, who had been good enough to prepare drawings on glass, suitable for projection on the screen, of his microscopical preparations. The first of these drawings showed a section of the already active electrical organ of a torpedo just born. It was seen to consist of a great number of tubular columns which extended from the upper (dorsal) to the lower (ventral) surface of the flattened body of the animal, which were as closely packed together as the cells of a honeycomb, each column being divided into very narrow compartments by nearly horizontal partitions of extremely fine membrane. It was next pointed out that, although the whole organ is made up in the common torpedo of as many as 500 such columns (in some species many more), each column is in structure and in function an electrical organ of itself; and not only so, but that each of the fine membranous partitions or *plates* is an electromotive structure of which, notwithstanding its almost inconceivable tenuity, the two opposite surfaces are, when in activity, in different electrical states; so that, in consequence of their pile-like arrangement and their all acting in the same direction, the electromotive force excited by the whole column is, as in a voltaic battery, equal to the *sum* of the forces exerted by the many hundreds of plates of which it is composed.

It having thus been made evident that everything depended on the plates, the lecturer proceeded to explain their minute structure, for the investigation of which it was of course necessary to employ much higher powers. The microscopical drawings which were thrown on the screen showed that each of the fine membranes which had been described consists of two different structures. Its upper surface presents a layer of apparently homogeneous material in which nuclei are distributed at intervals. This may be called the protoplasmic lamina. The under or ventral layer might be called the nerve-lamina, for it is made up of the arborizations of the innumerable nervous filaments which spread themselves over the protoplasmic lamina on its under surface. As these filaments branch repeatedly as they approach their destination, their ultimate endings are among the smallest objects which can be distinguished under the microscope.

The electrical organ offers to the physiologist one of the most striking examples of that adaptation of structure to function which is universal among living beings. A single column of the organ of the torpedo resembles in a very remarkable degree a voltaic pile, of which the plates are the elements, but it is a resemblance with a difference. The difference lies in this, that the organ is only a battery when it is waked into activity by a stimulus. This waking up or (to use the ordinary language of physiology) excitation is derived from the animal's brain, which for the purpose has added to it a special electric lobe on each side, from which the enormous nerves, which are so richly supplied to the electrical organ, emanate. The use of this lobe is obviously not to produce electricity itself, but, at the will of the animal, to set free the energy of the organ, *i. e.* of each of the many thousand plates of which it consists. Thus, of the two laminæ of each plate, the nervous and the protoplasmic, each represents a distinct function—the protoplasmic that of producing the required electromotive effect, the nervous that of receiving from the brain and communicating to the protoplasm the impulse by which it is discharged.

In a former lecture it had been shown that all the ordinary physiological changes which occur at every moment of our existence in what Bichat called the organs of animal life, particularly in our nerves and muscles, are accompanied by electrical changes, and that although it is not yet possible to give any physical explanation of these changes, rapid progress is now being made in determining the laws of their association with the other physical concomitants of muscular and nervous action. As it is practically much more important to understand the physiology of muscle and nerve than that of the electrical organs of a few fish, the latter has been comparatively insufficiently studied. The purpose of the experiments made at Arcachon is to bring the phenomena of the electrical discharge or shock of the torpedo and the physiology of its organ into line with the already very accurately investigated phenomena of nerve and muscle. With reference to these last, certain very definite laws have been established, of which, perhaps, the most fundamental is that, when functionally at rest, these structures exhibit no electromotive action. The structure must have been *previously* acted upon by some external agency capable of exciting it. Another established fact is that the effect is of limited duration, and that for its development a certain time must elapse, which under similar conditions is always the same for the same structure. A third is that all kinds of excitants act in the same way, the effects differing in intensity, not in direction. In all these respects, and in others of less importance, the electrical plate agrees with muscle and nerve. Inasmuch, therefore, as we have met with a structure of which the development of electrical action is the exclusive function, there seems to be good reason for the hope that by its investigation a nearer approach may be made than has hitherto been possible to the central question—that of the reason why in all animal structures the transition from the inactive to the active state is, so far as our present knowledge teaches, always accompanied by electrical change.

The question why certain fish are endowed with so singular a means of offence and defence, which others allied to them zoologically do not possess, and, above all, why some fish have electrical organs so small as to be useless, is as difficult to answer now as when Mr. Darwin wrote the 'Origin of Species.' The facts relating to the development of the organ, which teach us to regard it as, in some sense, a modified muscle, might suggest that the transition from muscle to organ was a gradual one, determined by external conditions. But we are prevented from accepting any such suggestion by the consideration that an electrical organ only becomes advantageous to its possessor when it has acquired sufficient size to be used in the capture of prey, and that in all previous stages of transition it must be useless. Natural selection could not therefore determine the development of the electrical organ by modification of muscle. It is more reasonable to imagine that all fish, or at any rate certain families of fish, possess an undeveloped element of structure, of which the electrical organ is the manifestation. So that what we have to account for is not its presence in some exceptional cases, but its absence in the great majority.

The existence of such a tendency as this hypothesis supposes would render it possible for natural selection to operate efficiently in bringing about the observed result.

GEOLOGICAL SOCIETY.

November 9, 1887.—Prof. J. W. Judd, F.R.S., President, in the Chair.

The following communication was read:—

"Note on the so-called 'Soapstone' of Fiji." By Henry B. Brady, F.R.S.

The Suva deposit, which has a composition very similar to that of the volcanic muds at present forming around oceanic islands in the Pacific, is friable and easily disintegrated. The colour ranges from nearly white to dark grey, the mass being usually speckled